Implementation of an Enhanced Communication System for the Acute Evaluation and Treatment of Cerebral Vascular Ischemia

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INTRODUCTION

One of the challenges for acute stroke intervention is the rapid recognition, diagnosis, and treatment within 3 hours of stroke[1]. In rural areas, the time, distance, and neurologic expertise compound the situation. The aims of this project were to develop the database for rapid diagnosis, integrate the software with other data sources and teleconferencing software, train physician users in use of the software and teleconferencing, implement the system in hospitals of varying sizes representing different capabilities and patient populations, and evaluate use of the system between hospitals.

METHODS

The development of the information for dissemination and inclusion in the system for rapid diagnosis and consultation of acute myocardial ischemia (AMI) and acute brain ischemia (ABI) patients used clinical guidelines from the American College of Cardiology and the American Heart Association for AMI[2] and from the American Heart Association for ABI[3].

The development of a database and software for rapid diagnosis and consultation of AMI and ABI patients was done using a relational database, 4D, on Macintosh computers. The database was designed to be entered into a stand-alone database at the rural hospital using a computer located in the hospital's local emergency room. The database was integrated into the Emergency Department Consultation And Triage System (EDCATS).

The rural hospitals are connected to the University of Iowa Hospital and Clinics and the Internet using T1 and frame-relay cabling technology. Network connectivity provides a more extensive way to communicate between hospitals, allowing for the transfer of electronic data and video.

The performance of the system, including computed tomography (CT) scan evaluation and full-motion video for assessment of the neurological examination, was done in a pilot project.

Four neurologists and two radiologists independently interpreted 23 CT scans showing a variety of abnormalities with stroke. The examiners interpreted the scans using videoconferencing software, and each interpreted the same scans in a different order using a traditional view box. Another pilot project evaluated the interrater reliability of scoring the National Institutes of Health Stroke Scale (NIHSS) in patients with acute stroke by videotaping and transmitting the examination at a remote site compared with bedside observation. Twelve patients with acute stroke had an NIHSS (scores ranging from 1 to 13) recorded at the bedside using hand-held digital camera. The agreement among the four remote raters was assessed for each component of the NIHSS using a kappa statistic.

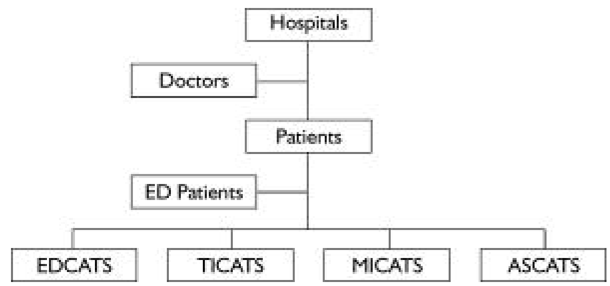

Figure 1. Enhanced Communication Databases

RESULTS

To disseminate the criteria for acute stroke and thrombolytic therapy, we placed descriptions on the Virtual Hospital Web site (www.vh.org).

The database was developed using the essential stroke diagnostic information. Automatic coding for NIHSS and key elements was done to decrease data entry time. The system was implemented on each local hospital computer. A centralized server was used to integrate the database and the transferred digital images. The size of the files made it necessary to transfer the files to a separate computer independent of the videoconferencing computer.

An evaluation of the pilot project of CT images showed that the quality of the CT image was equivalent whether using the view box or the computer. The average correct score was 95.7 percent with the computer system and 95.6 percent with the view box. The intrarater reliability was 92.2 percent. For acute ischemic stroke, the accuracy was lower—80 percent with the computer screen and 86 percent with the view box; the intrarater score was 81 percent.

Using the video-transmitted images of the neurological exam in the pilot project, the accuracy of the components of the NIHSS ranged from
69 to 98 percent (Table 1). The kappa scores varied from 0.32 (neglect) to 0.82 (sensory). The total NIHSS score was strongly correlated between the remote and bedside raters. (r=0.88; $P<.05$).

Table 1. Accuracy and Agreement for the Components of the NIHSS

Component	Accuracy (SE)	Kappa
LOC-Alert	94% (0.03)	
LOC-Questions	88% (0.05)	
LOC-Commands	98% (0.02)	
LOC-Combined		0.54
Best Gaze	81% (0.06)	0.35
Visual Fields	96% (0.03)	0.66
Facial Palsy	69% (0.07)	0.58
Motor-Left Arm	77% (0.06)	
Motor-Right Arm	90% (0.04)	
Motor-Arm		0.47
Motor-Left Leg	69% (0.07)	
Motor-Right Leg	81% (0.06)	
Motor-Leg		0.39
Limb Ataxia	83% (0.05)	0.51
Sensory	71% (0.07)	0.82
Best Language	92% (0.04)	0.45
Dysarthria	90% (0.04)	0.62
Neglect	81% (0.06)	0.32

The system was fully operational in 1999. Training and operational support were available to all centers. In 1 year of operation, there were no telemedicine consults. However we have increased the number of ischemic stroke phone calls and early administration of recombinant tissue plasminogen activator (rtPA). Four hospitals have developed acute stroke protocols as a result of our educational visits and NIHSS certification. The potential for telemedicine use has not changed from prior years, with approximately 58 stroke patients being consulted and transferred from the telemedicine hospitals alone. In 1999 there were 44 transfers while the system was operational in 9 months, or an estimated 58 in the year. Most of these consults were by telephone. Approximately 10 calls were for rtPA administration in stroke patients.

DISCUSSION

The project resulted in development of a system using current clinical guidelines and practices algorithms for data transfer of neurologic exam, radiologic images, and clinical vital data. The system offers an integrated pathway for consultation using a consultation network and data transfer that provides information via the Web, which can make the consultation available through Internet connections.

The accuracy of assessment of significant CT findings was subject to discipline and was equivalent to direct, view box interpretation. Digitization and electronic transmission of the NIHSS examination to a remote site do not introduce significant error when compared with bedside scoring.

The project was successful in building a system and developing a mechanism for consultation. However, there was lack of use of the system even though the local physicians believed that the system was worthwhile. The presumed lack of use was due to an increased knowledge and capability of the local hospitals and physicians in ABI and AMI management, as evidenced by development of their own protocols for treatment. Also, the physicians did not incorporate telemedicine into their practices because of infrequent need and use. ABI patients were not in high enough frequency to make telemedicine an everyday occurrence. There were no financial or contractual incentives for use of the system. The local hospitals and physicians did not view this part of the network or organization, nor did they have any vested interest in this program. The telephone provided the usual means of communication for consultation, even though less information was transferred.

CONCLUSIONS

We developed a system consistent with clinical guidelines and practice, and its capabilities were satisfactory for the assessment of the patient. However, use of the system by the physicians was less than expected and was due to development of their own capabilities and choice of consultation medium. It is possible to develop telemedicine systematic approaches that arise from substantial need in a rural environment, are developed with the full support and participation of community-based practitioners, demonstrate satisfactory diagnostic performance, and facilitate guidelines-based practice and yet still find the approaches underutilized in daily practice.

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